billion neutrinos will collide with a nucleon in the massive iron plates, and this collision produces a hadron shower of pions, muons, kaons and neutrons that release energy as they explode from the interaction. The particles hit liquid scintillation counters, which give off light when charged particles pass through them. The amount of light can then be converted into a measure of energy.

But the detector is not quite finished following the particles on their path. The last part of the detector, the toroid, is composed of 24 magnets and several drift chambers that bend muons coming out of the interaction. This bending measures the muons' energy. Bernstein was single-handedly responsible for the development of these special muon-bending drift chambers. "People have told me," says Bernstein, "that the development of these chambers was an event in the history of particle physics similar in importance to the development of the multi-wire chamber by Charpak. I disagree. This was much bigger." Bernstein's face flushes with the difficulty of attempting to describe his achievement. "Is it Nobel material,", he muses. "Let's just say that I've been practicing taking saunas."

Improving the Target

E815 has several improvements over the previous generation of similar fixed-target experiments. One change from prior experiments is the ability to separate neutrinos and antineutrinos in the beam. This gives new information about the relative strength of the interactions characteristic of the W and Z bosons, and allows the experiment to possibly uncover some parameters of the putative Higgs boson even before it is discovered. This process of using precision measurements to learn about undiscovered particles is an old technique. For instance, neutrino experiments, including the predecessors of E815, predicted the top quark mass to be 150 GeV or more long before the CDF/DZero discovery. "I'm not sure why they bothered verifying my work on the top quark," Bernstein commented, "but, hey, it's a free country, right?"

So while the lesser scientists keep busy running shifts and working on their own projects, the computers are busy recording data to be analyzed later by Bernstein. Although the collaboration is relatively small, the physics output is only limited by the impressive bandwidth of Bernstein. Spentzouris pointed out that while the minor institutions on the experiment worry about small details, it is only Bernstein's genius that keeps the physics flowing.

Photos by Reidar Hahn

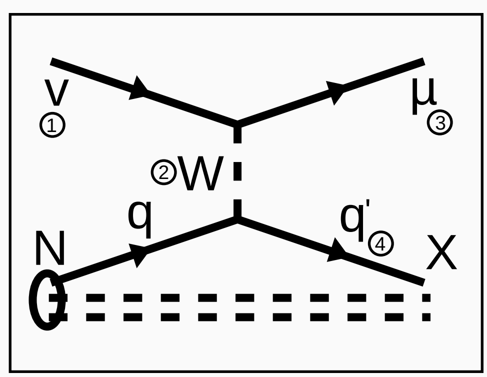
Lucy deBarbaro (above), a postdoc from Northwester University, and Howard Budd, a senior research associate, engage in a misguided attempt to fix a bad logic unit in the trigger room without Bob.

Sarah Case (left), an undergraduate from Columbia University, and Bob Drucker, a postdoc from the University of Oregon, analyze beamline monitoring. Without Bernstein's input, they look puzzled.

Bernstein Diagram

By studying the interaction below, researchers at E815 can compare the ratio of how many times a W boson is exchanged versus the number of times a Z boson is exchanged. This ratio is related to the weak mixing angle.

1. Neutrino beam enters detector.
2. A neutrino interacts with a quark (q) in a nucleon (N) from an iron nucleus, with the exchange of a W boson.
3. The neutrino changes into a muon.
4. The quark changes into a different flavor quark (q') as a result of the boson exchange. The X represents other hadrons from the interaction.



"We're like a big family," said Spentzouris. "We sometimes fight like kids in a sandbox, but our love for Bob Bernstein binds us in ways that are... well... unique and indescribable." This big bear of a man brushed away a tear. "We love our Bob."